AFS 4-5-4

FACT SHEET

FOR PART-TIME FARMERS AND GARDENERS

UNITED STATES DEPARTMENT OF AGRICULTURE

Liming Acid Soils

The degree of acidity in soil has a direct influence on the quantity and quality of a crop. An acid soil can restrict the root and top growth of plants, reduce the availability of plant nutrients, decrease desirable biological activity, and increase the availability of toxic elements in the soil (see fig. 1). If soil acidity is not managed properly, full benefit of other expensive and time consuming soil management practices cannot be realized.

What Is An Acid Soil?

Soil and organic matter particles that hold high concentrations of hydrogen or aluminum, or both, cause a soil to become acidic. The soil and organic matter particles carry a negative charge that hold or adsorb such positive elements as hydrogen, calcium, magnesium, potassium, sodium, and aluminum. Soils vary in their ability to hold these positive elements. The total amount of elements that can be held by the soil and organic matter particles is known as the soil's cation exchange capacity.

The term "pH" refers to the degree of acidity of a soil. The pH of soil indicates the concentration of hydrogen ions held on the clay and organic matter particles. A pH of 7.0 is neutral; below 7.0 is acid, and above 7.0, alkaline. The lower the pH (below 7.0), the more acid the soil. The higher the pH (above 7.0), the more alkaline the soil. A soil with a pH of 5.0 is 10 times more acid than one with a pH of 6.0, and 100 times more acid than one with a pH of 7.0.

What Causes Acid Soil Conditions?

Soil acidity develops gradually in humid regions as abundant precipitation percolates through the soil, carrying dissolved nutrients below the root zone. (This is called leaching.) Growing plants also remove calcium and magnesium from the soil. The lost calcium and magnesium is replaced by hydrogen and aluminum, resulting in increased soil acidity. The use of acid-forming fertilizers also contributes to soil acidity.

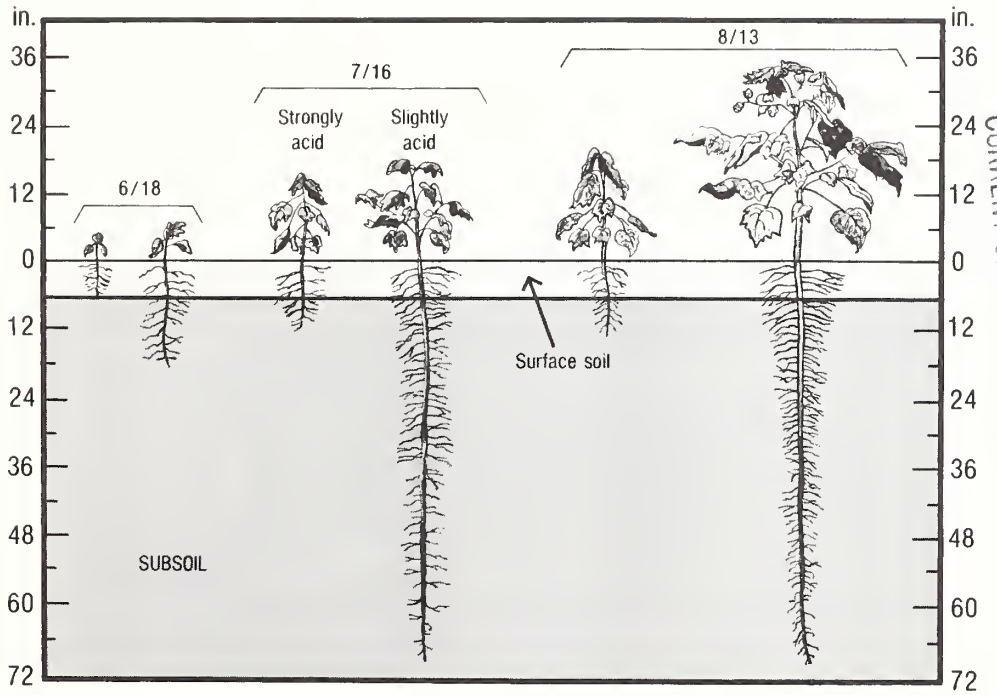

FIGURE 1.—Acid soils restrict rooting and plant height.

How Is Soil Acidity Corrected?

Soil acidity can be corrected when hydrogen or aluminum held by soil and organic matter particles are replaced with calcium or magnesium. Finely ground limestone is one of the most commonly used materials. If calcium is the only element needed, calcitic limestone is used. If magnesium is also needed, dolomitic limestone is used.

Maintaining the proper soil pH is as important for maximum crop yields as fertilizing, watering, and pest control. The decision to lime and the amount to apply must be based on soil tests and the crop species to be grown. Some plants, like azaleas and cranberries, grow best in acid soil.

Figure 2 can be used as a guide in determining the best pH range for different crops. For example, the preferred pH range for many kinds of grasses is from 5.5 to 7.0. Therefore, a desirable pH value for most lawns is 6.5. Agricultural experiment stations and extension services operate soil-testing laboratories in almost every State. Soil-testing services are also available from many private companies. These laboratories will determine the pH of your soil and tell you how much lime is needed. Some garden stores sell pH test kits and you can measure the pH yourself. If you use the test kit, table 1 can help determine the amount of lime needed.

Table 1 gives approximate amounts of lime required to increase the pH of soils of different textures. As a general rule, light sandy soil requires less lime to increase the soil pH than a heavy clay soil.

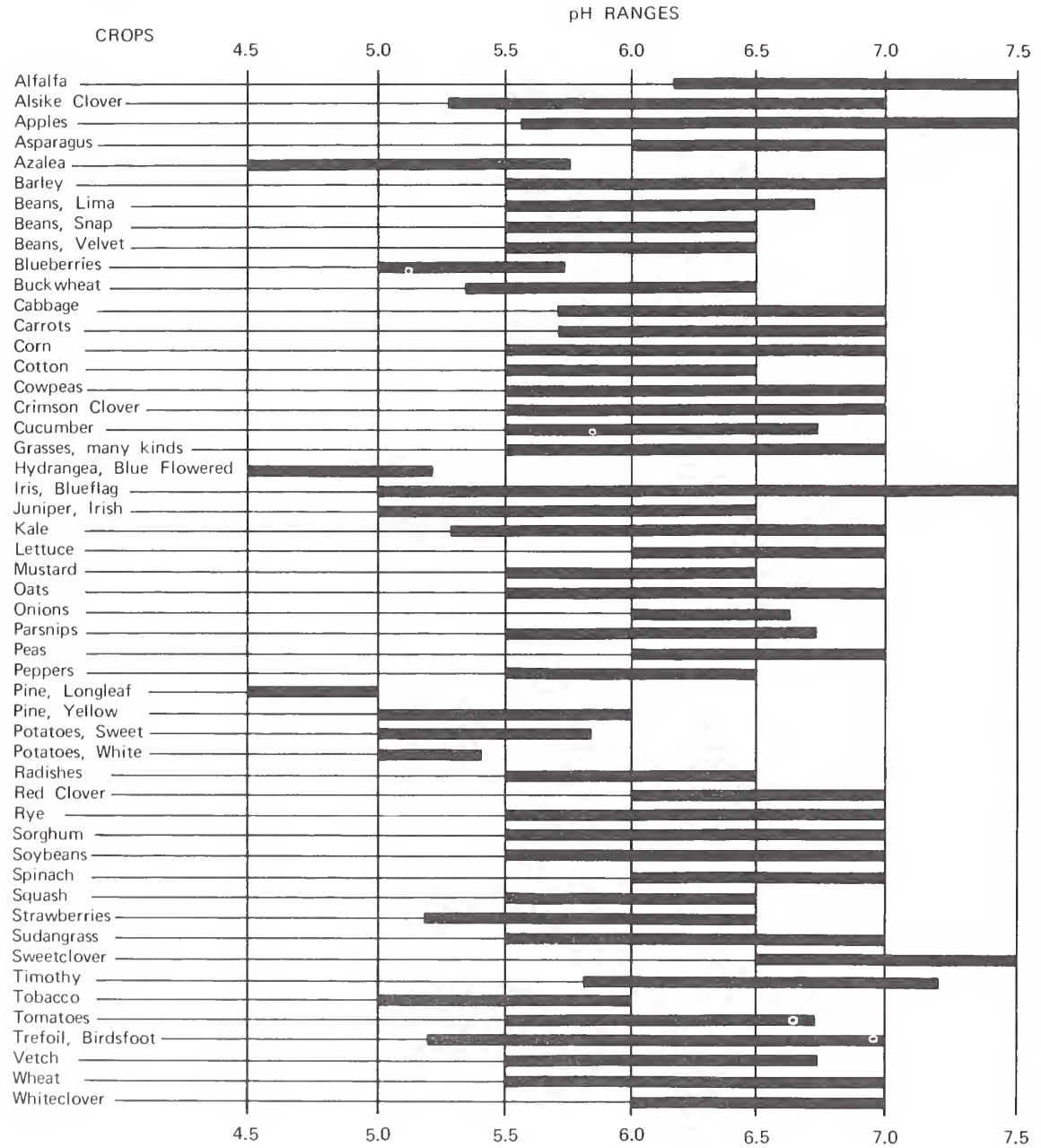

FIGURE 2.—Preferred soil pH range for maximum growth of different crops.

TABLE 1.—Approximate amount of ground limestone needed to increase the pH of the 7-inch (18 cm) plow layer of 5 soil types to 4 pH ranges

Texture of 7-inch (18 cm) plow layer	pH range			
	4.5 to 4.9	5.0 to 5.4	5.5 to 5.9	6.0 to 6.4
	Pounds of lime per 1,000 square feet[1]			
Sands	115	92	69	23
Loamy sands	138	115	92	46
Sandy loams	184	138	115	69
Clay loams and loams	230	184	138	92
Clays and silty clays	270	230	184	92

[1]Lime recommendations are based on a ground limestone material with a neutralizing value of 90 percent. To convert to pounds per acre, use this value multiplied by 43.5.

Adapted from Donahue, Follett, Tulloch, "Our Soils and Their Management," 1976.

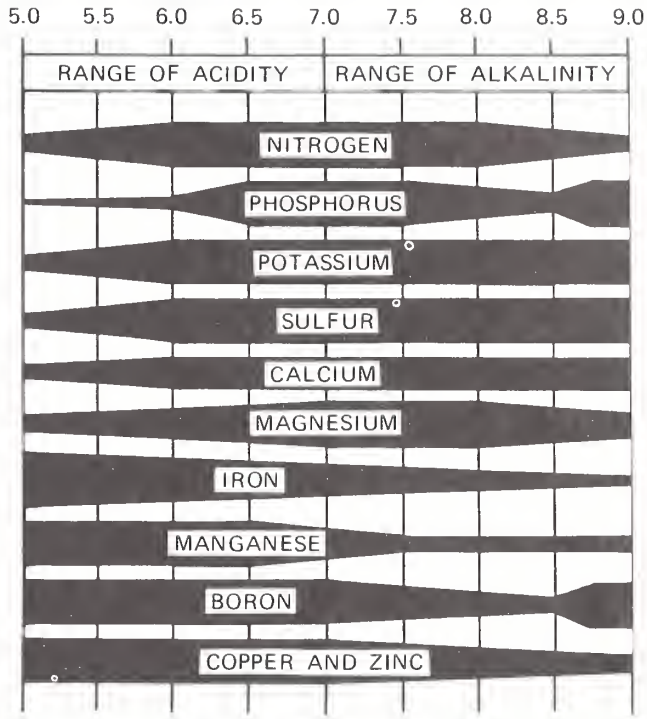

FIGURE 3.—Effect of change in pH on the availability of plant nutrients.

What Does Lime Do?

Lime corrects soil acidity, supplies calcium or magnesium, or both, improves the availability of some plant nutrients, promotes desirable biological acidity, and improves the structure of some soils. Proper liming combined with other desirable soil-management practices usually brings increased yields of better quality crops.

As shown in figure 3, the availability of plant nutrients changes as the soil pH is increased or decreased. Overliming, especially of sandy soils low in organic matter, can reduce yields of some crops by markedly reducing the availability of some nutrient elements. It is difficult to lower the pH of a soil that has been overlimed. Two ways of lowering the pH of an overlimed soil, however, are to apply sulfur or to increase the CO_2 content of the soil air by incorporating large amounts of organic matter like manure or crop residue.

What Can Be Used As A Liming Material?

The type of liming material one chooses is generally determined by the need for magnesium, availability, cost, rate of reaction with soil, and ease of handling and storage.

Table 2 lists some common forms of liming material and their characteristics. The effectiveness of a liming material in correcting acidity is determined by its neutralizing value or power. Pure calcium carbonate has a neutralizing power of 100; other liming materials are compared on a percentage basis with pure calcium carbonate.

Because of impurities and other forms of carbonates in liming materials, the neutralizing power of commercial products can range from 50 to 200 percent. Most high-calcium limestones have a neutralizing power between 75 and 95 percent. When a material contains appreciable amounts of magnesium carbonate, calcium hydroxide, calcium oxide, or magnesium oxide, the neutralizing power will be greater than 100 percent.

When And How Should Lime Be Applied?

Generally, lime can be applied anytime the soil is not too wet to drive or walk on. However, since lime should be thoroughly mixed with the surface soil for maximum effectiveness, the best procedure is surface application followed by tillage. For land that is not tilled, lime should be applied in early spring when freezing and thawing are taking place or in the fall after a long, dry period. If the soil test shows that pH should be increased substantially, the lime should be applied at least 3 or 4 months before it is needed by the crop to allow sufficient time for reaction with the soil.

TABLE 2.—Some common forms of lime

Common name	Other names	Characteristics	Neutralizing power
			Percent
Limestone (calcic).	—	Almost entirely calcium carbonate.	75 to 95
Limestone (dolomitic).	—	Contains up to 50 percent magnesium carbonate.	95 to above 100
Limestone (dolomite).	—	Almost entirely magnesium carbonate.	100 to 120
Burned lime	Quicklime, caustic lime, lump lime, unslaked lime.	Fast-acting; disagreeable to handle (caustic); more expensive than limestone.	150 to 185
Slaked lime	Hydrated lime, caustic lime, agricultural hydrade.	Fast-acting; disagreeable to handle (caustic); more expensive than limestone.	125 to 145
Marl	—	Soft, early material; localized use.	90 to 95
Industrial lime	(Including-acetylene lime, calcium silicate, gashouse lime, lime-kilm ashes, tanners' lime, fluidized bed wastes, cement kiln dust.)	Variable in composition; may contain toxic quantities of impurities.	Variable; generally high.
Wood ash	—	Hardwoods contain about one-third more calcium than softwoods.	30 to 70
Coal ash	—	May improve soil's physical condition.	Little or no liming value.
Ground or burned mollusk shells.	—	Good liming material; localized use.	Up to 95

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